Evaluation of the Energy-Smart Pricing Plan[SM]

Project Summary and Research Issues

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February 2004

Funding for this report was provided by the
Illinois Department of Commerce and Economic Opportunity (Grant 02-19502)

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S PROJECT SUMMARY AND RESEARCH ISSUES

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This report presents results from both a quantitative and process assessment of the Community Energy Cooperative's (Cooperative) Energy-Smart Pricing Plan[SM] (ESPP) residential real-time pricing (RTP) program for the year 2003. The ESPP program is the first large-scale residential RTP program in the United States. The fundamental questions addressed in this assessment include the following:

- Will residential customers respond to hourly market-based electricity prices?
- What actions can and do residential customers take to respond to hourly prices?
- What is the magnitude of the effect, i.e., to what degree can consumption be affected through the behavior and actions of residential and small commercial customers?

This project summary is divided into six sections (1) background on the issues and importance of appropriate pricing, (2) a description of the pricing offer and value proposition for customers embodied in the ESPP, (3) a first-year quantitative assessment of the impacts of the program, (4) a process assessment examining customer acceptance and satisfaction with the pricing program, (5) an initial examination of the non-energy benefits that customers may receive from the pricing program, and (6) overall conclusions.

S.1 Background and Issues

This project addresses some of the central issues associated with providing residential customers electric price signals that reflect the changing costs of providing electricity. Electricity is unique in that it can not be stored in significant quantities.[1] As a result, during periods of high demand (e.g., high temperature summer days), hourly electric prices can vary substantially over just a 12-hour period, easily spanning a factor of ten. On extreme days, price spikes during resource constrained periods can see increases of one hundred fold, if there is not demand-side response to

[1] Hydro-electric dams can provide for storage where available, but the limitations on additional end use of existing hydro-electric resources makes this form of storage increasingly scarce even in areas such as the Northwest where substantial hydro-resource development has taken place. Batteries do not yet provide economic storage alternatives.

mitigate the supply-side factors that drive prices up. These prices, even though they may occur only during a few hours each summer, can represent substantial cost to the market.

While the costs of electricity in wholesale markets can vary dramatically, retail pricing, particularly for residential and small commercial customers, has largely remained subject to regulated tariffs. These tariffs typically have provided customers with fixed rates, i.e., they pay the same price for electricity regardless of when and how much is used. This fixed rate does not reflect the true cost to the economy of consuming electricity at a given point in time, and therefore it distorts key market decisions.

An important near-term challenge facing electricity markets is the rational pricing of retail electricity. This is equally important for markets that have opened to competition and markets that remain regulated. The goal of any market — regulated or unregulated — is to allocate resources equitably, promote efficient investment and provide incentives for innovation. Prices provide the market signals that are used to allocate resources. The question that needs to be addressed by those administering, regulating, designing and participating in electricity markets is: How can we expect to have efficient markets if we do not price what is scarce, i.e., on-peak electricity use? The corollaries to this question are:

- If we don't price what is scarce (e.g., peak-period commodity), how do we incent innovation and enhance productivity in electricity markets?

- If we don't price what is scarce, how do we improve load factors in one of the country's most capital-intensive industries?

These simply stated questions have many ramifications. As long as consumers have flat rates, there is little incentive to manage what is scarce. With real-time pricing, residential customers still receive a monthly bill that represents an average of electricity costs. Now, this average would be based on their electricity use in each hour multiplied by the price for that hour. As such, it more effectively reflects the market cost of electricity. This allows customers to make informed decisions about their electricity use. For example, customers, who are able to shift electricity use from peak to off-peak hours would now be rewarded for their efforts with lower monthly bills.

Customer Choice, Market Benefits and Technology Innovation

A rationally priced retail electric market can support business cases for innovation. Companies such as Microsoft, Carrier and Honeywell, as well as organizations such as the Internet Home Alliance are developing equipment that will allow customers to manage demand while increasing overall comfort and benefits from energy services. The business cases for the development of these technologies depend, in part, on both business and residential customers seeing savings result from managing peak demand. Appropriate pricing reflecting what is costly and scarce will allow customers to be passive and still save money. The technology companies will have the business case needed to innovate and develop new energy management technologies. They will drive change in key equipment and energy management technologies.

Innovative pricing such as RTP is one method of enhancing demand response by customers in response to market signals. Retail electric prices that better track the costs of obtaining power in wholesale markets can provide benefits to electricity markets including the following:

- Increased system reliability as price mitigates demand when resources become scarce.
- Appropriate pricing of retail electricity can reduce the costs of electricity to all customers in a regional market.
- Risk management by allowing customers to manage part of the price and commodity risks to obtain the level of risk that they are comfortable with.
- Environmental benefits by promoting efficient use of resources and price signals to manage demand.
- Customer services through customer choice and reward for energy management.
- Market power mitigation by providing a demand response to offset high prices for generated electricity.
- Providing the incentives for innovation needed to create technologies and value propositions for load management and peak demand response.

Rational pricing of electricity can provide for these benefits through a balanced relationship with generation resources as wholesale energy markets have transitioned to competitive structures. While actions by the Federal Energy Regulatory Commission (FERC) and state public utility commissions (PUCs) have opened up wholesale energy supply markets to independent power producers (IPPs) with market-based pricing and eased entry, load management programs and innovative rates programs have declined as traditional utilities have shut down these programs with the expectation that competitive retailers would eventually provide these services. However, these competitive retail markets have not developed. The result has been less price responsiveness on the demand-side while, at the same time, the wholesale markets have become deregulated with less price control, particularly during peak periods.

Providing customers with fair choices and options to manage their electricity use and lower overall costs can provide market benefits. Studies have shown that substantial benefits to all customers can result from having relatively small amounts of consumption (e.g., 3 to 5 percent of peak demand) capable of responding to high price peak periods.

In an effort to capture the significant benefits of having retail prices of electricity reflect the cost of power in wholesale markets, The Community Energy Cooperative, in association with ComEd, has developed the first significant effort to introduce hourly market-based electricity pricing to residential customers. The details of this program are discussed below.

S.2 Community Energy Cooperative's Energy-Smart Pricing Plan

The Community Energy Cooperative's Energy-Smart Pricing Plan[SM] was started in January 2003. It provides customers with the opportunity to make informed decisions about electricity use by having electricity prices accurately reflect the market cost of electricity. This program uses hourly energy pricing information provided through Commonwealth Edison (ComEd) to develop hourly prices for participants and interval meters funded through the Illinois Department of Commerce and Economic Opportunity (DCEO) to record the hourly energy use. In addition to the hourly electricity price, participants' bills contain an access charge representative of a pass-through distribution charge. Based on historical prices, the Cooperative estimated that participants could be expected to save about 10% of their current electric costs under this rate design even if they did not change their energy use patterns in response to the hourly energy prices.

The ESPP is available to any ComEd customer willing to join the Cooperative. Initial marketing of the ESPP was targeted to Cooperative members and selected neighborhoods. About half of the program's participants are new Cooperative members, which reflect the marketing effort to go beyond current members to recruit program member/participants. In 2003 more than 750 customer members enrolled in the program.

S.3 Quantitative Assessment of Year-One Program Impacts

While there is a general consensus that there are significant benefits to the economy with retail electricity prices that reflect the market of power, there is some controversy as to the practicality of implementing such prices, particularly for the residential sector. There is the argument that residential customers cannot respond to hourly prices because they cannot easily alter their consumption in respond to price changes.[2] The fundamental purpose of this analysis is to determine if residential customers can respond to hourly prices.

The impact evaluation addressed the following key issues:

- Do participants respond to hourly prices?
- Do participants respond differently during high price periods?
- Are there common factors among those individuals, who consistently have a large response to high prices?

[2] This has lead to the belief that residential RTP is only possible once complex energy management systems have been developed. ESPP was specifically designed without such technology to see if it is indeed necessary for an effective response.

- How are ESPP participants different from Cooperative members, who have chosen not to participate?

- Does this decision to participate bias the effect of the program?

The statistical analysis for the price response models was based on the development of an econometric model that combined weather data with customer electricity consumption data collected by meters measuring consumption every fifteen minutes. For the quantitative assessment, data were available both across households (i.e., cross-sectional) and over time (i.e., time-series). With cross-sectional/time-series data, also known as "panel" data, it becomes possible to develop statistical approaches that can control for differences across customers, as well as differences across periods in time. The basic approach used is termed a "fixed-effect" model. The fixed-effect refers to the estimation of customer-specific intercept terms, i.e., if there are 750 customers in the analysis, then there are 750 separately estimated intercept terms. These "fixed-effects" terms capture differences among customers (e.g., house size, base energy use, occupancy patterns) that are relatively constant over the three-month study period. Given the short duration of the study period, the fixed-effects model is a good tool for cross-sectional/time-series analysis.

The major results from the quantitative assessment ESPP program were estimated using data from August 2003. This period was substantially cooler than normal with peak-period prices corresponding lower than previous years. However, the general results of the assessment include the following:

- Overall, the quantitative assessment demonstrated that participants do indeed respond to hourly prices. In fact, well over half of all participants showed significant responses to price notifications, with most of the rest of the participants showing some response.

- Residential customers responded to hourly prices (over and above the "high price" notification) with a price elasticity of -4.2%, which can result in significant changes in electricity demand.

- There is a strong response to notification of high prices over 10 cents/kWh, with consumption decreasing in some cases by more than 25% in the first hour. This response tapers off both (1) over the length of the high price period, and (2) as the number of successive days of notifications increase.

- Conventional wisdom for the marketing of RTP programs indicates that programs should focus on the largest single-family homes and those with the largest energy use, since they are most likely to have the most opportunities to shift load. However, the results from this year-one assessment indicate that program participants who live in multi-family dwellings exhibit the largest responses to high hourly energy prices. Such participants who own central air conditioners reduce their electric use compared to their baseline use by almost 30% overall during high priced periods. Multi-family program participants with room air conditioners or no air conditioners reduce their overall electric use during high priced periods by about 16% to 19% overall.

- In response to high-price notifications, single-family homes with central air conditioning tended to reduce their consumption significantly during the first two hours of a high-price period. In the third hour, there was little to no reduction and in later hours consumption started to increase (or "snap back"). This snapback result bears more examination to understand whether it is due to participants' decisions, the thermodynamics of their homes, or the specific characteristics of the thermostats provided in the program (which were designed to anticipate future cooling needs).

- The actions taken by customers, who had the largest reductions in their electric use during periods of high prices ("high responders") include turning down their air conditioners (room units), turning off lights, and turning up the air conditioner thermostat more than other participants. Higher income and older households were less likely to be high responders to high-price notifications.

- The fact that lower income households were more likely to be in the "high responder" group also runs counter to conventional wisdom. These high-responders also were participants who tended to use their air conditioner units more during low-price hours, presumably to pre-cool the house, and had window rather than central air conditioning. With central conditioning, the most likely response is to turn up the thermostat a few degrees which can lead to an initial reduction in demand, but then snapback when the new temperature setting is hit by the house. Window air conditioning units may simply have been turned off or turned down. This year-one assessment produced a number of hypotheses that should be examined more directly in year two to characterize high-responders and the actions taken.

- Participants were more likely than non-participants to have a higher income, to have recently added insulation to keep cool, and were more likely not to have changed any major appliances in the last year. Participants were less likely to have larger households and also were less likely to use fans for cooling to save energy.

- The participation model was used to address the potential for self-selection bias in the models, i.e., the fact that those who chose to be in the pilot were self-selected due to unique characteristics. It was found that the incorporation of a self-selection variable in the energy use model did not change the results discussed above. In other words, while there are differences between participants and non-participants, these differences are not correlated with customers' responses to hourly energy prices.

The results for the year-one assessment need to be verified in year two. The additional data that will be provided with a second summer of energy use should allow for the exploration of new hypotheses such as persistence of effects. (Do people respond in year one, but then becomes less responsive in year 2; or alternatively, do participants respond at greater levels once they become accustomed to the program?)

S.4 Process Assessment

The process evaluation examined the planning, implementation, and control processes of the Cooperative and how these processes may have affected the participation level and energy impact of the program. This effort focused on members' experience with the ESPP.

The process assessment utilized mail surveys of participating, control group and non-participating Cooperative members. Key results from the survey efforts included the following:

- Participants and control group members signed up for the ESPP to save money (and control their energy bills — see the Non-Energy Benefits discussion). They also were motivated by a desire to achieve environmental benefits and reduce the likelihood of electric outages.

- Participants' interaction with the ESPP has been favorable. About a quarter have had some interaction since signing up for the program, including obtaining information about the price alerts and other ESPP related program details. Various ideas were noted by respondents to improve program operations and support, but these tended to be constructive refinements to the existing process, not reflections of being dissatisfied. It does appear, however, that alternative communication methods are important to many participants. While the ESPP website was useful, about half of the participants do not have actively used internet access at home and alternative communications methods should also be used.

- ESPP participants were extremely satisfied with the program. They liked the help provided by the program, and the reminders (via price alerts and other information) to take their price-adaptive actions. And, they were satisfied with the energy-saving actions taken — more so than non-participants and control group members. Given the relatively cool summer of 2003, a hotter summer in 2004 could more severely test participants' adaptive limits.

- Participants can significantly change their behavior in response to the ESPP. For example, a large portion of participants shifted their clothes washing to nighttime during high price periods.

- Participants expected to save in the range of $5-$25 per month, with a plurality expecting about $10/month savings. The general program satisfaction ratings given imply that the expectations were met with very few respondents indicating that the savings they did achieve were insufficient or not worthwhile.

- There may be limits to some participants' ability to respond beyond the levels reached in the pilot program so far, as indicated by some of the comments received. In particular, a thread of comments suggested that some sort of assistance in making longer-term "capital" improvements such as appliance replacement and insulation services could be a complementary service to members. An air conditioner exchange program has been implemented by the Cooperative previously, and other equipment and service programs that increase the ability of ESPP participants to respond to prices are likely to be well received.

- Participants generally had few comments on how to improve the program, with most comments suggesting refinements to existing program processes.

- All groups shared many demographic characteristics; however, participants and control group members tend more to live in single-family homes, have fewer residents and higher incomes, and have greater internet access than the non-participant group of Cooperative members.

- About half of the non-participant Cooperative members who responded to the survey indicated they were aware of the ESPP, mostly through the Cooperative's mailings. They stated a variety of reasons for not participating, though no one reason seemed to dominate.

The conclusions from this process assessment represent the information from the first year of program operations of a three-year program. Longer-term evaluation issues not addressed by this evaluation include the program's overall market potential, a detailed assessment of the program's operating efficiency, and its overall cost effectiveness. These issues will be addressed as experience is gained in years two and three of the program.

S.5 Non-Energy Benefits

Non-energy benefits (NEBs) include the range of positive and negative impacts — beyond energy savings — that result from the program. While traditional measure-based programs often focus on a broader range of benefits deriving from installation of specific measures, for a number of reasons we focused on the benefits to participants of the ESPP. The participant survey included a series of questions into the participant survey that would allow for and assessment of NEBs that participants associated with the program.

The NEBs that were addressed in the survey included:

- value of perceived control, i.e., the ability to manage their energy use and impact their energy bill;

- effect on the environment;

- understanding gained about energy use; and

- equipment received.

The results indicate the following:

- Overall, it was possible to obtain information on NEBs valued by ESPP participants. The range of values that participants placed on the NEBs as compared to the bill reduction attained via price response through the program, indicated that an additional 50 percent to 100 percent of the value of the bill reduction could be attributed to non-energy benefits — with the "ability to manage" energy use being the most valued NEB.

- Although the primary motivation for participation in ESPP was to save money on the energy bill, the ability to have better "control over the bill" is overwhelmingly appreciated — and highly valued — by participants.

- Marketing the program on those features recognized as valuable by customers should help increase participation. In addition, the "control" and "environmental" NEBs are benefits that can continue to provide to customers value even in years when weather or other factors mitigate potential bill savings.

S.6 Overall Conclusions

Overall, the results of the first year of this program are very positive. During a relatively cool summer with unusually low peak energy prices, participants had a strong response to high price notifications and overall demonstrated the ability to adjust consumption in response to price. Well over half of all participants showed significant response to price notifications, with most of the rest of participants showing some response. Participants overall were extremely satisfied with the program, finding it easy to understand and to participate in. They were pleased with the bill savings they experienced in the program, and they placed a high value on benefits of the program beyond their direct dollar savings.

The experience of the ESPP to date shows that real-time pricing for residential customers can be an effective approach, and that a program can be designed that enables participants to understand and respond to the price patterns without placing an undue burden on them.

We expect that much additional information will be obtained in the second and third years of the program, as it gains more experience and as it experiences a wider range of weather and energy prices. In addition, the results of this evaluation can contribute to further program refinements to assist participants in managing their energy use.